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Research Article

Does The Volatility Structure of Double Registered Stocks Differentiate According to Stock Exchanges?

Çifte Kayıtlı Pay Senetlerinin Volatilite Yapısı Borsalara Göre Farklılaşır mı?

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Abstract

This study was conducted to investigate the volatility structures and leverage effects of double-registered stocks. Daily frequency price data of six Turkish ADRs covering the period 01.01.2010 - 01.11.2021 were used in present analyses. In this study, the univariate asymmetric stochastic volatility model was applied. Each stock was modeled separately for both domestic and foreign markets and following findings were obtained: A volatility shock that will come to the stocks whose second registration is in OTC Market was found to be more permanent than in BIST. Negative shocks to stock volatility in OTC Market increased the volatility more than positive shocks as compared to BIST, so the leverage effect was more effective in OTC Market. The volatility of the stocks, whose second stock market record was in New York Stock Exchange (NYSE), was more predictable in BIST. In addition, the leverage effect of stock volatility in NYSE was not found to be significant.

Key Words: Double registered stocks, leverage effect, volatility structure, stochastic volatility model, Turkish ADR.

Öz

Çalışmanın amacı, Borsa İstanbul'a kote olup aynı zamanda yurt dışındaki piyasalarda işlem gören pay senetlerinin volatilite yapılarını ve kaldıraç etkilerini incelemektir. Bu amaçla çalışmada, altı adet Türk ADR'nin 01.01.2010 – 01.11.2021 dönemini kapsayan günlük frekanstaki fiyat verileri kullanılmıştır. Volatilite modellerinden, tek değişkenli asimetrik stokastik volatilite modelinin uygulandığı çalışmanın tahmin yöntemi, Markov Zinciri Monte Carlo olarak belirlenmiştir. Her pay senedinin hem yurt içi hem de yurt dışı piyasalar için ayrı ayrı modellendiği çalışma sonucunda elde edilen bulgular şu şekildedir: Pay senetlerinin ikinci kaydı OTC Market'te olan tüm firmaların pay senetlerine OTC Market'de gelecek olan bir volatilite şokunun BIST'tekinden daha kalıcı olduğu tespit edilmiştir. Bununla birlikte, OTC Market'deki pay senedi volatilitelerine gelen negatif şokların pozitif şoklara göre volatiliteyi BIST'e göre daha fazla artırdığı, dolayısıyla kaldıraç etkisinin OTC Market'te daha etkili olduğu sonucuna ulaşılmıştır. İkinci borsa kaydı NYSE'de olan pay senedi volatilitesinin ise BIST'te daha öngörülebilir olduğu belirlenmiştir. Ayrıca NYSE'deki pay senedi volatilitesinin kaldıraç etkisinin istatistiksel açıdan anlamlı olmadığı bulgusu elde edilmiştir.

1. Intruduction

Contrary to continuously changing economic and technological structure, the search for capital is the primary unchanging condition for companies. Providing needed capital under the most favorable

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conditions, which is the primary issue of financing, directs companies to various financial assets. Companies need various assets to initiate and sustain their operations. The choice of meeting this capital need through equity and foreign resource financing may vary based on the situation of the firm and the economy.

It is possible to meet the capital need from both domestic and foreign resources. In particular, publicly traded companies can meet these needs by registering in a foreign stock exchange as well as the local stock market. In fact, in today's conditions, where competition is increasing and technological developments are accelerating, being listed on a foreign exchange seems advantageous in various aspects. This method, so called as double registration, is especially important in terms of increasing firm recognition and realizing capital transfer between the countries.

Company preference of listing their stocks in more than one exchange allows to reduce capital costs and increase liquidity. American Depositary Receipts (ADR), also so called as international stocks, is one of the financial instruments that allows stocks to be listed in foreign stock markets (Chena, Choi and Kim, 2008, pp. 346-347). Double-registered stocks, which open up to global markets and provide companies with a competitive advantage, may exhibit different performances based on the stock market in which they are traded since the structures of different countries' stock exchanges are different. Therefore, the prices of stocks belonging to the same company vary between stock exchanges. Volatility is an indicator of sudden changes in stock prices and it is among the important factors affecting decision-making processes in financial markets. Volatility is also used by investors to predict their stock returns and it is possible for volatility to have different structures in stock markets. From this point of view, in this study, structure and leverage effect of the stock volatility of the companies whose stocks are listed on Borsa Istanbul and also traded abroad were investigated. Initially, a literature review was provided, then data set and methodology were mentioned and finally results were assessed a conclusion was drawn.

2. Literature

When the studies on double-registered stocks were examined, it was seen that there were studies with significant contributions to the literature in various aspects. Contrary to national literature, there are several studies on subject matter especially in foreign literature. For instance, the differences in value of double-registered stocks before and after they were listed in the second stock exchange have been examined in some studies. There are studies reporting increased stock values with the spread of the news about public offering in foreign stock markets (Cetorelli and Peristani 2010; Foester and Karolyi 1993; Ko et al. 1997; Korczak and Bohl 2005; Serra 1997). On the other hand, there are also studies reporting decreased variance of the stock following the trade in foreign stock market (Kayali and Çelik 2009; Oudni et al. 2015); reporting increased risks (Akım 2013; Tripathy 2020); indicating insignificant effects of such news on stock values (Abdallah 2005). There is even a study investigating profit distribution levels of companies after they are listed in foreign stock market and reporting increased levels (Chen et al. 2021).

Previous researchers also investigated how the stock market prices of double-registered stocks traded in different stock exchanges were influenced by each other. Accordingly, there are studies reporting unidirectional affection of stock prices by information flow from domestic to foreign stock markets (Alhaj-Yaseen et al. 2014; Hauser et al. 1998; Mak and Ngai 2005). Others reported that domestic stock market prices were affected by foreign stock market prices (Brockman and Hao 2011; Eichler 2012; Xu and Fung 2002). Additionally, American, Canadian and Australian stock markets were also investigated and there are studies reporting a one-way relationship in stock prices from American stock markets to Australian stock markets (Alaganar and Bhar 2002), as well as studies reporting unidirectional relationship from American stock market to Canadian stock market (Kaul and Mehrotra 2006). On the other hand, there are studies indicating that stock prices in foreign stock market were different from the prices in national stock market (Gallagher and Kiely 2005; Sabherwal 2000) and studies reporting higher prices in foreign stock markets (King and Segal 2004).

The returns of stocks registered in domestic and foreign stock exchanges have also been examined in several studies. Accordingly, there are some studies indicating linear movements of prices and returns

of double-registered stocks with each other (Aksoy and Dayı 2008; Bedi et al. 2003; Dale and Jithendranathan 2001; Handsa and Ray 2003; Yerdelen Kaygın and Barut 2020;) that concluded that.

While some of the studies (Liu and Bogomolov 2012) examining whether an arbitrage profit could be obtained with double-registered stocks indicated that arbitrage profits could be obtained with these securities, some (Mederios and Lima 2016; Yang and Kun 2014) indicated that there was no arbitrage opportunity with these securities.

Effects of double-registered stocks on the development of local stock markets were also investigated in previous studies. Besides the studies finding double-registered stocks effective on development of domestic stock market (Moel 2001), there are also studies that found neither a positive nor a negative effect of double-registered stocks on development of local markets (Karolyi 2004).

There are also some studies encountered in literature about the effects of double-registered stocks on the firm's financial leverage levels (Yang and Lai 2021). Some of the studies investigating whether the volatility of double registered stock prices was from the domestic stock market to the foreign stock market or from the foreign stock market to the domestic stock market (Aquino and Poshakwale 2006), concluded that the volatility in domestic stock market significantly influenced the prices in the foreign stock market. Some others (Sarkissian and Schill 2016) found that price fluctuations in the foreign stock market influenced the local stock market.

3. Method

Volatility, so defined as the movements in the form of decreases and increases in the prices of financial assets, is a characteristic feature of financial time series. ARCH-type models, developed by Engle (1982) and commonly used in modeling volatility, are established largely on the assumption of observable conditional volatility. However, the main feature of the stochastic volatility model, which was first introduced by Taylor (1986), is that volatility should be modeled as an unobservable latent variable. In addition, as compared to ARCH and GARCH-type popular models, it is stated that stochastic volatility models were more suitable for the basic empirical features observed in daily financial series (Broto and Ruiz, 2004, p. 613).

There are various features of financial asset returns. These are features such as leptokurtic (extremely flattened) distributions, presence of volatility clusters, volatility spread from one asset to another, variation of correlations over the time and the presence of leverage effect (Yu and Mayer, 2006, p. 364). Considering these features, stochastic volatility models, which were stated to yield more successful outcomes as compared to the other volatility models due to the model structure, are divided into univariate and multivariate models.

Univariate models; have been developed and divided into groups based on different features such as two-factor, non-linear, threshold value, long-memory, average and asymmetric stochastic volatility models (Hepsağ, 2013, p. 49). In asymmetric stochastic volatility (ASV) model, the opinion that negative news increased the volatility of any financial assets more than the positive news is dominant. Therefore, the asymmetric stochastic volatility model, so assessed as more rational, is known as the most studied model in the literature as compared to the other models (Hepsağ, 2013, p. 62).

Asai and McAleer (2005) further developed the ASV model introduced into the literature by Harvey and Shephard (1996) and explained the changes in financial asset returns and volatility with the dynamic leverage effect. The leverage effect in this model is typically determined through the direct correlation between changes in both returns and volatility and resulted in a dynamic leverage model. The effect of the sign and size of the historical returns in the classical stochastic volatility model is also taken into account in dynamic leverage (DL) effect model. The representation of the model is as follows (Asai and McAleer, 2005, pp. 317-319):

$$y_t = \varepsilon_t \, exp\left(\frac{h_t}{2}\right) \qquad t = 1, \dots, T \qquad (1)$$

$$\varepsilon_t \sim N(0,1)$$

$$h_{t+1} = \mu + \varphi h_{t-1} + \eta_t$$

$$\eta_t \sim N\left(0, \sigma_\eta^2\right)$$
$$E(\varepsilon_t, \eta_t) = \rho\sigma_\eta$$

where; y_t is the average return of an asset, h_t is its stochastic volatility. In Equation 1, if $\rho<0$, then such an asymmetrical relationship can be expressed by a stochastic volatility model with dynamic leverage effect. But if $\rho=0$, then there is no dynamic leverage between returns and change in volatility. The representation of the stochastic volatility models with dynamic asymmetric leverage effect (DAL-SV), in which volatility is affected by both the sign and size of past returns of financial assets, is as follows (Asai and McAleer, 2005, pp. 319):

$$h_{t+1} = \mu + \varphi h_t + \gamma_1\gamma_t + \gamma_2|\gamma_t| + \eta_t$$
$$\eta_t \sim N(0, \sigma_n^2) \quad (2)$$
$$E(\varepsilon_t\eta_t) = \rho\sigma_\eta$$

In Equation 2, if $\gamma_1 = \gamma_2 = 0$, then DAL model transforms into standard DL model. The most important assumption of the DAL-SV model is that $\gamma_1+\gamma_2 < -(\gamma_1-\gamma_2)$, in other words, $\gamma_1 < 0$. The magnitude of the effect of a unit positive shock should be smaller than that of a unit negative shock. Direct application of DAL model to real data can cause problems because of the following reason. By giving ε_t to the model in notation Y, the DAL model can be written as (Asai and McAleer, 2005, p. 320):

$$h_{t+1} = \mu + \varphi h_t + \rho\sigma_n\varepsilon_t + \{\gamma_1\varepsilon_t + \gamma_2|\varepsilon_t|\}\exp(h_t/2) + \eta_t$$
$$\eta_t = N(0, \sigma_n^2(1-\rho^2)) \quad (3)$$

In notation 3, since ε_t and $\varepsilon_t\exp(h_t/2)$ are placed together, the multicollinearity problem is encountered. To overcome this problem, an alternative DL model (DL2) was proposed by introducing $\gamma=0$ constraint in notation (4) and it was determined that this model worked without any problems (Asai and McAleer, 2005, p. 320):

$$h_{t+1} = \mu + \varphi h_t + \gamma_2|\gamma_t| + \eta_t$$
$$E(\varepsilon_t\eta_t) = \rho\sigma_\eta \quad (4)$$
$$\eta_t \sim N(0, \sigma_n^2)$$

In short, the asymmetric stochastic volatility model, which allows the correlation between ε_t and η_t and allows this correlation coefficient (ρ) to be significant and to determine the leverage effect based on its sign, was preferred as the application methodology of this study. In estimation of univariate stochastic volatility models, the Markov Chain Monte Carlo (MCMC) estimation method is the most widely used similarity-based estimator. In this study, MCMC with Bayesian interference was preferred. This method has a prior distribution, a similarity function and a posterior distribution. WinBUGS 1.4 software and 50.000 samples were used for estimations.

3.1. Data Set and Empirical Findings

In this study, volatility of double-registered stocks in both domestic and foreign stock markets was investigated with the use of price data of Turkey's ADRs. The data set is at daily frequency and covers the period of 01.01.2010 - 01.11.2021 for all stocks. The data were obtained from the websites tr.investing.com and wsj.com. As of October 2021, there were 21 companies whose stocks are traded both in Borsa Istanbul (BİST) and in a foreign stock exchange. Among these companies, the ones without data for the period 01.01.2010 - 01.11.2021 and the ones with a status of a financial institution were excluded from the sample. Thus, within the scope of the study, the stocks of 6 companies were examined and these companies are provided in Table 1.

Table 1: Companies constituting research sample

	Company Name-Code in BİST	**Company Name – Code – Foreign Stock Market in which the company is traded**
1	Anadolu Efes Biracilik ve Malt Sanayi A.Ş. – AEFES	Anadolu Efes Biracilik ve Malt Sanayii AS ADR – AEBZY – OTC
2	Arçelik A.Ş. – ARCLK	Arcelik AS ADR – ACKAY – OTC
3	Koç Holding A.Ş. – KCHOL	Koc Holdings AS – KHOLY – OTC
4	TAV Havalimanlari Holding – TAVHL	Tav Havalimanlari Holding AS – TAVHY – OTC
5	Turkcell İletişim Hizmetleri AŞ – TCELL	Turkcell Iletisim Hizmetleri AS – TKC – NYSE
6	Türk Hava Yollari AO – THYAO	Turk Hava Yollari AO – TKHVY – OTC

Descriptive statistics for return series of the stocks of the companies constituting research sample are provided in Table 2.

Table 2: Descriptive statistics for stock returns of the companies

	Mean	**Max.**	**Min.**	**S.D.**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**P**
AEFES	0.000415	0.123907	-0.11583	0.020409	0.04079	6.186765	1257.14*	0.00
AEBZY	1.104001	1019.354	-0.99903	33.55255	30.33128	920.9913	32550673*	0.00
ARCLK	0.000939	0.109009	-0.10553	0.020884	-0.01815	5.177833	586.9065*	0.00
ACKAY	0.000581	0.254713	-0.33978	0.041479	-0.26796	12.28354	3480.469*	0.00
KCHOL	0.000857	0.099548	-0.11604	0.019444	-0.11679	5.015316	509.1908*	0.00
KHOLY	0.000223	0.122807	-0.20519	0.023652	-0.2457	7.012036	2014.328*	0.00
TAVHL	0.001044	0.282132	-0.16185	0.025319	0.37777	12.01677	10128.37*	0.00
TAVHY	0.000307	0.407386	-0.22917	0.037864	1.153334	19.01293	15017.03*	0.00
TCELL	0.000432	0.122421	-0.12658	0.01755	-0.03839	6.79484	1781.63*	0.00
TCK	-0.00029	0.116773	-0.20069	0.02021	-0.56644	9.473055	5356.597*	0.00
THYAO	0.000696	0.16	-0.2	0.024564	-0.16197	7.463705	1846.896*	0.00
TKHVY	0.0000344	0.291139	-0.38333	0.055299	-0.79211	11.70423	1738.319*	0.00

Note: **: significant at 1% level.*

Abbreviations: Max. Maximum, Min. Minimum, S.D. Standard Deviation, P Probability.

When the descriptive statistics of double-registered stock returns were examined, it was seen that absolute standard deviation values of all series were greater than the mean values. Such a case indicated that means were not significantly different from zero, so the time series followed a random walk process. On the other hand, it was seen that return series mostly had a negative skewness value and distribution of the series was positive based on kurtosis value. Therefore, there was a thick-tailed distribution as compared to normal distribution. In addition, Jarque-Bera test statistics revealed that distribution of the return series was not normal (p=0.00).

In presents, univariate ASV model was used and analyses were conducted for each company separately, thus a total of 12 models were examined. Resultant findings were summarized in the same table for each

firm to compare the status of company in the stock exchanges where it is traded and thus the model findings of six firms are provided in Tables 3 - 8.

Table 3: ASV model findings of Anadolu Efes Biracilik ve Malt Sanayi A.Ş. for BIST and OTC Market

		Mean	SD	MC Error	Confidence interval	
AEFES	**μ**	-8.193**	0.06767	0.003955	-8.326	-8.061
	ϕ	0.8348**	0.02858	0.002823	0.778	0.8865
	ρ	-0.1282**	0.04715	0.003807	-0.2208	-0.03444
	σε	0.01664**	5.64E-04	3.30E-05	0.01556	0.01776
	ση	0.4955**	0.05167	0.005569	0.3947	0.5963
AEBZY	**μ**	-8.079**	1.407	0.03717	-10.82	-5.93
	ϕ	0.9917**	0.009267	4.24E-04	0.9652	0.9995
	ρ	-0.3608**	0.1748	0.01041	-0.6666	-0.00617
	σε	0.02207**	0.01405	4.15E-04	0.004468	0.05155
	ση	0.1968**	0.04558	0.002978	0.1239	0.3007

Note: **, significant at 5% level.

According to estimation results of leveraged stochastic volatility model of Anadolu Efes, presented in Table 3, it was seen that all coefficients were significant. The ϕ coefficient, an indicator of continuity of volatility, was calculated as 0.8348 for BIST and 0.9917 for OTC Market. Accordingly, it was stated that a volatility shock to company stocks in OTC Market was more permanent than in the BIST. The variance of σ_η coefficient (σ_η^2), indicating variability of the volatility, was calculated as 0.2455 for BIST and 0.0387 for OTC Market. A value close to 0 indicates that volatility persistence was high. Therefore, the results obtained for ϕ and σ_η^2 coefficients support each other. In addition, the ρ coefficient, expressing the relationship between the changes in stock volatility and its return, was obtained as -0.1282 for BIST and -0.3608 for OTC Market. These findings indicated that the correlation between the shocks to which stock returns and volatility were exposed was negative in both BIST and OTC Market. However, since the value was greater in OTC Market, it was determined that Anadolu Efes stock volatility had a stronger and more significant leverage effect in OTC Market. In other words, it was determined that negative shocks to stock volatility in OTC Market increased volatility more than the positive shocks.

Table 4: ASV model outcomes of Arçelik A.Ş for BIST and OTC Market

		Mean	SD	MC Error	Confidence interval	
ARCLK	**μ**	-7.989**	0.0579	0.001671	-8.102	-7.874
	ϕ	0.8687**	0.02842	0.001686	0.7997	0.9133
	ρ	-0.2169**	0.05466	0.002436	-0.3217	-0.1074
	σε	0.01842**	5.34E-04	1.54E-05	0.0174	0.0195
	ση	0.3516**	0.04279	0.002733	0.2805	0.4514
ACKAY	**μ**	-7.015**	0.3691	0.01098	-7.879	-6.589
	ϕ	0.9468**	0.0264	0.001517	0.8858	0.9909
	ρ	-0.2187**	0.1061	0.005169	-0.4268	-0.0071
	σε	0.03038**	0.004283	1.24E-04	0.01946	0.0371
	ση	0.2932**	0.06266	0.004023	0.1851	0.4349

Note: **, significant at 5% level.

According to estimation results of stochastic volatility model of Arçelik A.Ş, presented in Table 4, it was seen that all coefficients were significant. Since the ϕ coefficient was calculated as 0.8687 for BIST and 0.9468 for OTC Market, it was understood that stock volatility had more permanent effects in OTC Market. The σ_η^2 coefficient was calculated as 0.1236 for BIST and 0.0859 for OTC Market. Therefore, supporting the finding obtained with ϕ coefficient, it was seen that variability of stock volatility was lower in OTC Market. The ρ coefficient was calculated as -0.2169 for BIST and -0.2187 for OTC Market (Table 4). Accordingly, there was a leverage effect of almost the same magnitude on stock volatility in both markets.

Table 5: ASV model outcomes of Koç Holding A.Ş. for BIST and OTC Market

		Mean	SD	MC Error	Confidence interval	
KCHOL	μ	-8.09**	0.06516	0.001844	-8.217	-7.959
	ϕ	0.9128**	0.02269	0.001385	0.8579	0.9488
	ρ	-0.1433**	0.06503	0.003086	-0.2757	-0.02047
	σε	0.01752**	5.72E-04	1.62E-05	0.01643	0.01869
	ση	0.265**	0.03832	0.002508	0.2028	0.3563
KHOLY	μ	-7.724**	0.06519	0.001961	-7.851	-7.596
	ϕ	0.9209**	0.01925	0.001159	0.8789	0.9547
	ρ	-0.2463**	0.06591	0.003499	-0.3788	-0.1158
	σε	0.02104**	6.86E-04	2.07E-05	0.01973	0.02241
	ση	0.2458**	0.03389	0.002214	0.1819	0.3156

Note: **, significant at 5% level.

According to estimation results of stochastic volatility model of Koç Holding A.Ş, presented in Table 5, it was seen that all coefficients were significant. The volatility persistence (ϕ) was greater in OTC Market with a 0.0081% difference. Therefore, Koç Holding's stock volatility had more persistent effects in OTC Market. Likewise, since σ_η^2 coefficient was closer to 0, it was understood that the volatile structure of Koç Holding stock in OTC Market was more predictable than BIST. In addition, negative ρ coefficient indicated that stock volatility had a leverage effect in both markets. However, negative shocks had a greater impact on stock volatility than positive shocks, since the magnitude was greater in OTC Market.

Table 6: ASV model outcomes of Tav Havalimanlari Holding AS for BIST and OTC Market

		Mean	SD	MC Error	Confidence interval	
TAVHL	μ	-7.759**	0.07281	0.003516	-7.9	-7.613
	ϕ	0.8863**	0.02375	0.002161	0.8369	0.9272
	ρ	-0.1288**	0.05561	0.004262	-0.2333	-0.02155
	σε	0.02068**	7.54E-04	3.64E-05	0.01925	0.02223
	ση	0.3801**	0.04492	0.004404	0.305	0.4692
TAVHY	μ	-7.134**	0.2594	0.00895	-7.615	-6.747
	ϕ	0.9664**	0.01277	0.001218	0.9394	0.9884
	ρ	-0.272**	0.08647	0.00832	-0.4319	-0.09452
	σε	0.02845**	0.003181	1.02E-04	0.02221	0.03426
	ση	0.2249**	0.03814	0.004326	0.1629	0.3028

Note: **, significant at 5% level.

According to estimation results of stochastic volatility model of Tav AS, presented in Table 6, it was seen that all coefficients were significant. Since the ϕ coefficient was closer to 1 and the σ_η^2 coefficient

was closer to 0, it was understood that the volatility of Tav stocks was more predictable in OTC Market than in BIST. In addition, according to the ρ coefficient, stock volatility had a leverage effect in both markets. Therefore, negative shocks to stock volatility in OTC Market increased volatility more than the positive shocks.

Table 7: ASV model outcomes of Turkcell Iletisim Hizmetleri AS for BIST and OTC Market

		Mean	SD	MC Error	Confidence interval	
TCELL	μ	-8.381**	0.05719	0.002825	-8.489	-8.265
	ϕ	0.8395**	0.03049	0.002724	0.7823	0.8996
	ρ	-0.1048**	0.05343	0.003739	-0.2068	-9.67E-04
	σ_ε	0.01515**	4.34E-04	2.15E-05	0.01434	0.01604
	σ_η	0.404**	0.04257	0.004055	0.319	0.4789
TCK	μ	-8.168**	0.06089	0.00156	-8.288	-8.047
	ϕ	0.8527**	0.02755	0.001577	0.7967	0.902
	ρ	-0.1718**	0.05318	0.002323	-0.2744	-0.06311
	σ_ε	0.01684**	5.13E-04	1.32E-05	0.01586	0.01789
	σ_η	0.3504**	0.04576	0.002843	0.3374	0.516

Note: **, significant at 5% level.

Table 7 shows the estimation results of stochastic volatility model of Turkcell Iletisim Hizmetleri AS. It is seen that all coefficients were significant in the model results of Turkcell, which is the only company traded in a stock market other than OTC Market among the double-registered stocks examined within the scope of the present sample. Since the ϕ coefficient was closer to 1 and the σ_η^2 coefficient was closer to 0, it was understood that the volatility shocks for Turkcell's stock were more permanent in NYSE than BIST. In addition, according to the ρ coefficient, stock volatility had a leverage effect in both markets. Therefore, negative shocks to stock volatility in NYSE increased volatility more than the positive shocks.

Table 8: ASV model outcomes of Turk Hava Yollari AO for BIST and OTC Market

		Mean	SD	MC Error	Confidence interval	
THYAO	μ	-7.786**	0.06603	0.003512	-7.914	-7.657
	ϕ	0.8391**	0.02908	0.002798	0.7768	0.8862
	ρ	-0.258**	0.05092	0.003917	-0.3609	-0.1574
	σ_ε	0.02039	0.67	3.59E-02	0.01912	0.02174
	σ_η	0.4378**	0.04461	0.004783	0.3659	0.5323
TKHVY	μ	-6.397**	0.1519	0.003203	-6.705	-6.107
	ϕ	0.7632**	0.07194	0.003369	0.5987	0.878
	ρ	0.01678**	0.09557	0.002937	-0.1675	0.2036
	σ_ε	0.04093**	0.0031	6.57E-05	0.03499	0.0472
	σ_η	0.6587**	0.1113	0.006073	0.4655	0.8932

Note: ** significant at 5% level.

According to estimation results of Turkish Airlines AO's stochastic volatility model presented in Table 8, it was seen that the volatility persistence (ϕ) was greater in BIST. Therefore, it was understood that Turkish Airlines stock volatility was more predictable in BIST as compared to NYSE. Likewise, since the σ_η^2 coefficient was closer to 0, it was seen that the volatile structure of Turkish Airlines stock in BIST had more permanent features than in NYSE. In addition, since ρ coefficient was significant and

negative only for BIST, it was seen that Turkish Airlines stock volatility had a leverage effect in BIST. The result obtained in the NYSE was not found to be significant.

4. Conclusion

International financial markets are in continuous integration due to increasing speed of globalization and changing technological infrastructure. Therefore, with increasing integration, trading ratio of foreign assets are also increasing stock markets of different countries. On the other hand, countries spend their efforts to take the capital circulating in international markets and needed within the national borders. One of the methods used to provide the needed capital in this way is the listing stocks of public companies in international stock exchanges. In this way, stocks of the companies became double-registered.

The market price in foreign countries where the double-registered stocks are issued and the market prices in local stock exchange may differ, because there are different internal factors that affect the economies in general and the stock markets of the countries in particular. Since the effects of these factors vary in each market, prices also vary accordingly. Large increases or decreases in prices formed as compared to average value indicate volatility of relevant stocks. Volatility plays a key role in financial markets and it should be taken into account especially by potential investors.

In this study, univariate asymmetric stochastic volatility model was applied to investigate volatility structures of double-registered stocks and to assess whether there was a leverage effect. Analyses were conducted for 6 companies between the period of 01.01.2010 - 01.11.2021. The stock certificates not meeting the previously specified constraints were excluded from the sample. The model was applied separately to national and foreign stock markets of each company, thus 12 model structures emerged then. Resultant findings were summarized in Table 9.

Table 9: Summary of ASV Model outcomes

	μ	ϕ	ρ	σ_ε	σ_η^2
AEFES	-8.193**	0.834**	-0.128**	0.016**	0.245**
AEBZY	-8.079**	0.991**	-0.360**	0.022**	0.038**
ARCLK	-7.889**	0.868**	-0.216**	0.018**	0.123**
ACKAY	-7.015**	0.946**	-0.218**	0.030**	0.085**
KCHOL	-8.09**	0.912**	-0.143**	0.017**	0.070**
KHOLY	-7.724**	0.920**	-0.246**	0.021**	0.060**
TAVHL	-7.759**	0.886**	-0.128**	0.020**	0.144**
TAVHY	-7.134**	0.966**	-0.272**	0.028**	0.050**
TCELL	-8.381**	0.839**	-0.104**	0.015**	0.163**
TCK	-8.168**	0.852**	-0.171**	0.016**	0.122**
THYAO	-7.786**	0.839**	-0.258**	0.020	0.191**
TKHVY	-6.397**	0.763**	0.016	0.040**	0.433**

*** significant at 5% level.*

The ϕ coefficients (Table 9) indicated that continuity of volatility was higher in OTC Market for all companies whose second stock market registration was in OTC Market. Therefore, it could be stated that a volatility shock to company stocks will be more permanent in OTC market than in BIST. Besides, σ_η^2 coefficients, indicating variability of volatility, also showed that volatility persistence of the stocks in OTC Market was higher for the companies listed in OTC Market. In other words, stock volatility of the companies was more predictable in OTC Market as compared to BIST. Therefore, the results obtained for the ϕ and σ_η^2 coefficients support each other. The ρ coefficients, used in to find out the asymmetric and leverage effect, revealed that volatility of all stocks registered in OTC Market and BIST had the leverage effect. However, when evaluated in terms of magnitude, it was understood that negative shocks to stock volatility in OTC Market as compared to BIST increased volatility more than the positive shocks.

In present sample, Turk Hava Yollari AO is the only company that is not listed in OTC Market, but on NYSE. According to ϕ and σ_η^2 coefficients in Table 9, it was seen that stock volatility was more predictable in BIST as compared to NYSE. Since the ρ coefficient was significant and negative only for BIST, it was seen that stock volatility in BIST had a leverage effect.

It was concluded based on present findings that stock volatility of the same companies in different stock markets was more predictable in OTC Market as compared to BIST and more predictable in BIST as compared to NYSE. In addition, the leverage effect, indicating that the effect of negative shocks on volatilities was greater than the positive shocks, was identified only for stocks in OTC Market and BIST. Therefore, the volatility structures of the stocks of the same company traded in different stock exchanges may differ. Here, the factors affecting the stock markets in different countries were evaluated and investors are expected to make a choice according to their risk levels.

In both national and foreign literature, there is no other study examining the volatility persistence and leverage effect of double-registered stocks. Therefore, this study is considered to have significant contributions to literature. In this study, only Turkey was examined as the local stock market, thus further research is recommended to examine the other countries and for comparison of volatility structures.

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Araştırma Makalesi

Does The Volatility Structure of Double Registered Stocks Differentiate According to Stock Exchanges?

Çifte Kayıtlı Pay Senetlerinin Volatilite Yapısı Borsalara Göre Farklılaşır mı?

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Genişletilmiş Özet

Sürekli değişen ekonomik ve teknolojik yapının aksine, firmalar açısından değişmeyen koşulların başında sermaye arayışı gelmektedir. Finansmanın temel konusu olan, ihtiyaç duyulan sermayenin en uygun koşullarda sağlanması, firmaları çeşitli finansal varlıklara yöneltmektedir. Çünkü firmaların faaliyete geçebilmesi ve faaliyetlerini devam ettirebilmesi için çeşitli varlıklara ihtiyacı vardır. Öz kaynak ve yabancı kaynak finansmanı şeklinde sağlanabilen bu sermaye ihtiyacının giderilme tercihi, firmanın ve ekonominin içinde bulunduğu duruma göre değişiklik gösterebilmektedir.

Sermaye ihtiyacının gerek yurt içinden gerekse de yurt dışından sağlanması mümkündür. Özellikle halka açık firmalar, yerel borsanın yanı sıra yabancı bir borsaya daha kayıt olarak bu ihtiyaçlarını karşılayabilmektedir. Hatta rekabetin arttığı ve teknolojik gelişmelerin hızlandığı günümüz şartlarında yabancı bir borsaya kote olmak, çeşitli açılardan avantajlı görünmektedir. Çifte kayıt olarak adlandırılan bu yöntem, özellikle firma tanınırlığının artması ve ülkeler arası sermaye transferinin gerçekleşmesi bakımından önemlidir.

Firmaların pay senetlerini birden fazla borsada listelemeyi tercih etmeleri, sermaye maliyetlerinin azalmasına ve likiditelerinin artmasına olanak sağlamaktadır. Uluslararası pay senetleri olarak adlandırılan American Depositary Receipts (ADR), pay senetlerinin yabancı ülke borsalarında kote olmalarını sağlayan finansal araçlardan biridir (Chena, Choi ve Kim, 2008: 346-347). Küresel piyasalara açılarak, firmalara rekabet avantajı sağlayan çifte kayıtlı pay senetleri, işlem gördükleri borsaya göre farklı performanslar sergileyebilmektedir. Bunun en önemli sebebi, farklı ülke borsalarının yapılarının farklı olmasıdır. Dolayısıyla aynı firmaya ait hisse senetlerinin fiyatları, borsalar arasında değişiklik göstermektedir. Bununla birlikte, pay senedi fiyatlarında meydana gelen ani değişikliklerin göstergesi olan volatilite, finansal piyasalarda karar alma süreçlerini etkileyen önemli faktörlerden birisidir. Yatırımcıların pay senedi getirilerini tahmin etmek amacıyla da kullandıkları volatilitenin, borsalar nezdinde farklı yapılarda olabilmesi söz konusudur. Buradan hareketle çalışmada, pay senetleri Borsa İstanbul'a kote olup, aynı zamanda yurt dışında da işlem gören firmaların pay senedi volatilitelerinin yapısının ve kaldıraç etkisinin araştırılması amaçlanmıştır.

Kaldıraç etkisinin belirlenmesine olanak sağlayan asimetrik stokastik volatilite modeli, bu çalışmanın uygulama yöntemi olarak tercih edilmiştir. Tek değişkenli stokastik volatilite modellerinin tahmininde, en çok benzerlik yöntemine dayalı tahmincilerden en çok kullanılan Markov Zinciri Monte Carlo (MCMC) tahmin yöntemidir. Bu çalışmada da Bayesian özelliği olan MCMC'nin kullanılması tercih edilmiştir. Bu yöntemin en temel özelliği bir önsel, bir benzerlik fonksiyonu ve bir de sonsal dağılımının

olmasıdır. WinBUGS 1.4 paket programının kullanıldığı çalışmada, tahmin yöntemine ilişkin 50.000 adet örneklemeyle çalışılmıştır.

Çifte kayıtlı pay senetlerinin hem yerli hem de yabancı borsalardaki volatilitelerinin araştırıldığı bu çalışmada, Türkiye ADR'lerinin fiyat verileri kullanılmıştır. Veri seti günlük frekansta olup, tüm pay senetleri için 01.01.2010 – 01.11.2021 dönemini kapsamaktadır. Çalışmanın örneklemini oluşturan firmalar Tablo 1'de verilmiştir.

Tablo 1: Örneklemi Oluşturan Firmalar

	BİST'te Şirketin Adı-Kodu	**Şirketin Adı – Kodu - İşlem Gördüğü Yabancı Borsa**
1	Anadolu Efes Biracilik ve Malt Sanayi A.Ş. – AEFES	Anadolu Efes Biracilik ve Malt Sanayii AS ADR – AEBZY – OTC
2	Arçelik A.Ş. – ARCLK	Arcelik AS ADR – ACKAY – OTC
3	Koç Holding A.Ş. – KCHOL	Koc Holdings AS – KHOLY – OTC
4	TAV Havalimanlari Holding – TAVHL	Tav Havalimanlari Holding AS – TAVHY – OTC
5	Turkcell İletişim Hizmetleri AŞ – TCELL	Turkcell Iletisim Hizmetleri AS – TKC – NYSE
6	Türk Hava Yollari AO – THYAO	Turk Hava Yollari AO – TKHVY – OTC

Tek değişkenli ASV modelinin kullanıldığı çalışmada, her firma için analizler ayrı ayrı yapılarak toplam 12 adet model incelenmiştir. Raporlanan sonuçlar Tablo 2'de özet olarak verilmiştir.

Tablo 2: ASV Model Sonuçları Özeti

	μ	ϕ	ρ	σ_ε	σ_η^2
AEFES	-8.193**	0.834**	-0.128**	0.016**	0.245**
AEBZY	-8.079**	0.991**	-0.360**	0.022**	0.038**
ARCLK	-7.889**	0.868**	-0.216**	0.018**	0.123**
ACKAY	-7.015**	0.946**	-0.218**	0.030**	0.085**
KCHOL	-8.09**	0.912**	-0.143**	0.017**	0.070**
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TAVHY	-7.134**	0.966**	-0.272**	0.028**	0.050**
TCELL	-8.381**	0.839**	-0.104**	0.015**	0.163**
TCK	-8.168**	0.852**	-0.171**	0.016**	0.122**
THYAO	-7.786**	0.839**	-0.258**	0.020	0.191**
TKHVY	-6.397**	0.763**	0.016	0.040**	0.433**

Tablo 2'deki ϕ katsayılarına göre, ikinci borsa kaydı OTC Market'te olan tüm firmalar açısından volatilite sürekliliğinin OTC Market'te daha yüksek olduğu görülmektedir. Dolayısıyla firmaların pay senetlerine OTC Market'te gelecek olan bir volatilite şokunun BIST'tekinden daha kalıcı olduğu ifade edilmektedir. Bununla birlikte, volatilite değişkenliğini gösteren σ_η^2 katsayıları da OTC Market'de kote olan firmalar açısından OTC Market'teki pay senetlerinin volatilite kalıcılığının daha yüksek olduğunu göstermektedir. Başka bir ifadeyle, firmaların pay senedi volatilitelerinin BIST'e kıyasla OTC Market'te

daha öngörülebilir olduğu anlaşılmaktadır. Dolayısıyla ϕ ve σ_η^2 katsayıları için elde edilen sonuçlar birbirini desteklemektedir. Asimetrik ve kaldıraç etkisinin belirlenmesinde kullanılan ρ katsayılarının sonuçlarına göre kayıtları OTC Market ve BIST'te olan tüm pay senetlerinin volatilitesi kaldıraç etkisine sahiptir. Ancak büyüklük açısından değerlendirildiğinde, BIST'e kıyasla OTC Market'teki pay senedi volatilitelerine gelen negatif şokların pozitif şoklara göre volatiliteyi daha fazla artırdığı anlaşılmaktadır.

Örneklemde ikinci borsa kaydı OTC Market'te olmayıp NYSE'de olan tek firma Turk Hava Yollari AO'dur. Tablo 9'daki ϕ ve σ_η^2 katsayılarına göre, pay senedi volatilitesinin NYSE'ye kıyasla BIST'te daha öngörülebilir olduğu görülmektedir. Ayrıca ρ katsayısının sadece BIST için anlamlı ve negatif olması, BIST'te pay senedi volatilitesinin kaldıraç etkisine sahip olduğunu ifade etmektedir.

Sonuç olarak, aynı firmaların farklı borsalardaki pay senedi volatilitelerinin BIST'e kıyasla OTC Market'te, NYSE'ye kıyasla ise BIST'te daha öngörülebilir olduğu bulunmuştur. Ayrıca negatif şokların volatiliteler üzerindeki etkisinin pozitif şoklardan daha fazla olduğunu ifade eden kaldıraç etkisi, sadece OTC Market ve BIST'teki pay senetleri için tespit edilmiştir. Dolayısıyla aynı firmaya ait farklı borsalarda işlem gören pay senetlerinin volatilite yapıları farklılık gösterebilmektedir. Burada farklı ülkelerdeki borsaları etkileyen faktörler değerlendirilerek, yatırımcıların risk seviyelerine göre bir tercih yapması beklenmektedir.

Hem ulusal hem de yabancı literatürde, çifte kayıtlı pay senetlerinin volatilite kalıcılığı ve kaldıraç etkisini inceleyen başka bir çalışmaya rastlanmamıştır. Dolayısıyla, bu çalışmanın literatüre yaptığı katkı bakımından önemli olduğu düşünülmektedir. Yerel borsa olarak sadece Türkiye'nin incelendiği bu çalışmada, ileriki çalışmalar için başka ülkelerin irdelenerek volatilite yapılarının karşılaştırılması önerilebilir.